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Evaluation of Supplemental Lights for Caution Bars

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Final Report

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16. Abstract

Caution Bars (stop bars or hold bars) are used to identify taxiway hold lines and warn pilots of an approaching runway. Caution Bars are difficult to see when they are covered by snow or sand, or when a high-cockpit aircraft is at or close to the caution bars. Under these conditions, supplemental lights (taxi-holding position lights) could help. This project was to determine the desired characteristics of horizontal and vertical coverage, intensity, flash rate, and orientation of the supplemental lights. The results indicated that these characteristics were acceptable or desired:

- Horizontal and vertical coverage: ±15 degrees (as shown by photometric data);
- Intensity: 30-percent night; 100-percent day (1600 candela light);
- Flash rate: 58 flashes/minute (off the shelf equipment); and
- Orientation: toe-in 20 degrees toward taxiway pitch-up 10 degrees above horizon.

The results also indicated that the lights would enhance identification of the taxi-holding position.

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METRIC CONVERSION FACTORS

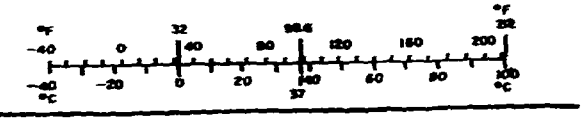
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
	inches	*2.5	centimeters	cm
	feet	30	centimeters	cm
	yards	0.9	meters	m
	miles	1.6	kilometers	km
		AREA		
	square inches	6.5	square centimeters	
	square feet	0.09	square meters	
	square yards	0.8	square meters	
	square miles	2.6	square kilometers	
	acres	0.4	hectares	
		MASS (weight)		
	ounces	28	grams	g
	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
	teaspoons	5	milliliters	
	tablespoons	15	milliliters	
	fluid ounces	30	milliliters	
	cups	0.24	liters	
	pints	0.47	liters	
	quarts	0.95	liters	
	gallons	3.8	liters	
	cubic feet	0.03	cubic meters	
	cubic yards	0.76	cubic meters	
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 exactly. For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	
cm	centimeters	0.4	inches	
m	meters	3.3	feet	
m	meters	1.1	yards	
km	kilometers	0.6	miles	
		AREA		
	square centimeters	0.16	square inches	
	square meters	1.2	square yards	
	square kilometers	0.4	square miles	
	hectares ($10,000 m^2$)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
	milliliters	0.03	fluid ounces	fl oz
	liters	2.1	pints	
	liters	1.06	quarts	
	liters	0.26	gallons	
	cubic meters	35	cubic feet	
	cubic meters	1.3	cubic yards	
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

This evaluation was performed in response to a request from the Office of Airport Standards. Caution bars are used to identify taxiway hold lines and warn pilots that they are nearing a runway. The caution bars are difficult to see when they are covered by snow or sand, or when a high-cockpit aircraft is at or close to the caution bar. Under these conditions, supplemental lights could help the pilot identify their location in relation to the hold line. This project was to determine the horizontal and vertical coverage, intensity, flash rate, and orientation of the supplemental light.

The literature uses various names and terms for the concept of supplemental lights. This report uses the name "taxi-holding position lights" as proposed by the Aerodromes, Air Routes and Ground Aids Division (AGA) of the International Civil Aviation Organization (ICAO) instead of the term "supplemental lights."

The evaluation compared two different fixtures by obtaining FAA test pilot responses. Six different variables were tested. They were intensity, flash rate, distance from taxiway edge, lens diameter, toe-in (towards taxiway), vertical angle (pitch-up). Also a general response to the overall usefullness was obtained. In addition, photometric data were obtained for the fixtures. The following characteristics were determined to be the most effective:

1. Intensity: 30-percent night, 100-percent day (1600 candela light)
2. Flash rate: 58 flashes/minute (off-the-shelf equipment)
3. Distance from taxiway edge: 20 feet from pavement edge and 36 inches above grade.
4. Lens diameter: 12 inches
5. Toe-in: 20 degrees toward taxiway
6. Vertical Angle: 10 degrees pitch-up
7. Horizontal and vertical coverage: ±15 degrees (as shown by photometric data)

The data also showed that the pilots felt that the taxi-holding position lights would provide enhanced identification of the taxi-holding position. However, they expressed the reservation that the lights should only be employed where operational experience showed that they are NEEDED.

INTRODUCTION

PURPOSE.

The purpose of this project was to determine the desired characteristics of supplemental lights for caution bars used at taxiway hold lines. The evaluation described in this report was performed in response to a request from the Office of Airports Standards (AAS-200). It was accomplished under Technical Program Document Number 08-493, Subprogram 081-502, Project 590 "Evaluation of Supplemental Lights for Caution Bars at Taxiway Hold Lines."

The request stated that "The present caution bar consist of a row of steady burning inpavement lights. These lights are difficult to see when the taxiway is covered with snow or when a high-cockpit aircraft is at or close to the lights. The addition of an elevated light on both sides of the taxiway and flashing in a wig-wag fashion could alleviate these deficiencies and would provide a bolder caution bar which could prove useful at locations having problems with inadvertent runway transgressions." The request also indicated that, as a result of the evaluation, recommendations should be provided for use in establishing the following equipment characteristics:

a. Horizontal and vertical coverage of the light beam.
b. Intensity of the light beam.
c. Flash rate of the lights.
d. Orientation of the main light beam.

The evaluation was also to consider whether the concept on use of such lights is an enhancement to the caution bars.

BACKGROUND.

CAUTION BARS. The Federal Aviation Administration (FAA) does not define "caution bars" in any Advisory Circular. The only related reference is to "hold bars" in AC 150/5340-19 "Taxiway Centerline Lighting System" which is defined as three bidirectional lights showing yellow in both directions, spaced at intervals of 1.5 M (5 ft) across the taxiway. Also these hold bars would only be used where the centerline lights are installed on straight centerlines and not with the curved centerline.

The International Civil Aviation Organization (ICAO) Annex 14 "Aerodromes," Chapter 5 "Visual Aids for Navigation," does not define "caution bars" but does define "stop bars" as "unidirectional lights showing red in the direction of approach to the intersection or taxi-holding position, spaced at intervals of 3 M (10 ft) across the taxiway." The definition we used for this project is identical to the ICAO definition of stop bars except, we have used the color yellow instead of red as follows:

> Caution bars are unidirectional lights showing yellow in the direction of approach to the taxi-holding position, spaced at intervals of 3 M (10 ft) across the taxiway.

SUPPLEMENTAL LIGHTS. ICAO Annex 14, Chapter 5.3.20.2, recommends the use of a pair of elevated lights at each end of the stop bar where the stop bar may be obscured.

The only statement about the characteristics of these lights says "these lights shall have the same characteristics as the lights in the stop bar, but shall be visible to approaching aircraft up to the stop-bar location." The name, Taxi-Holding Position Lights, is being proposed by ICAO Aerodromes Air Routes and Ground Aids Division for the elevated lights added to the end of the stop bar (reference 2). For this reason the term "Taxi-Holding Position Lights" will be used throughout this report instead of the term "Supplemental Lights."

Aerodromes Air Routes and Ground Aids Division of ICAO (reference 2) recommends that taxi-holding lights be provided at a taxi-holding position where a stop bar is required. The lights shall be located on each side of the taxi-holding position as close as possible to the taxiway edge. The lights consist of two unidirectional alternately illuminated yellow lights aligned to be visible to a pilot taxiing to the holding position. The intensity of the light should be adequate for the conditions of visibility and ambient light but should not "dazzle" the pilot. The lights will be illuminated alternately between 30 and 60 cycles per minute with the light suppression and the illumination periods equal and opposite in each light.

Desirable characteristics of the taxi-holding position lights were considered at the ninth meeting of the Visual Aids Panel (reference 3). The following ranges of characteristics were suggested by different members:

Intensity	Flash Rate
2 - 400 candela (cd)	30 to 60 per minute
200 - 400 cd	40 to 60 per minute
2000 cd	120 per minute
50 - 100 cd	60 per minute

Horizontal beam spread	Vertical beam spread
30 degrees	15 degrees
-15 to +30 degrees	0 to 15 degrees
+/-10 degrees	1 to 8 degrees
120 degrees	45 degrees
	120 degrees
	15 degrees

London/Heathrow Airport has taxi-holding position lights (called runway guard lights) which have been highly successful in preventing inadvertent runway transgressions by alerting pilots and drivers of ground vehicles that they are approaching a taxi-holding position and must obtain a clearance before proceeding (reference 4).

The requirement for taxi-holding position lights has not been established with respect to helping a pilot of high-cockpit aircraft accurately position the aircraft after the caution-bar lights or painted holding position markings have passed from his field of vision. In an evaluation conducted by the Technical Center in 1978 (reference 5), pilot's of Boeing 747's indicated that they were able to position the aircraft nose within a few feet of the holding position without need of supplemental guidance.

The taxi-holding position light may well serve the purpose of identifying the holding position when the caution-bar lights or painted markings are obscured by sand or snow. Reference 5 states that flashing lights adjacent to the edge of the taxiway at the taxi-holding location will provide an additional indication of the stopping point.

EVALUATION PROCEDURE

The evaluation compared effectiveness of two different light fixtures provided by AAS-200, a smaller fixture had two 8-inch diameter lenses and used two 69-watt 120-volt traffic signal lamps and a larger fixture had two 12-inch diameter lenses and used two 116-watt 120-volt traffic signal lamps (figure 1). Modifications to the standard fixtures were made to permit variations in intensity, flash rate, and orientation of the units.

The Taxi-Holding Position Lights were temporarily installed on taxiway A at the taxi-holding position line on the southwest side of runway 13-31 at the Federal Aviation Administration (FAA) Technical Center, Atlantic City Airport, New Jersey (figure 2). Taxiway A has green taxiway centerline lights and no caution-bar lights at the hold line. A temporary lighted caution-bar was set up using L-852W taxiway centerline lights. The FAA test pilots, using a Convair 540 and Aerocommander 680E aircraft, performed the necessary taxi testing of the system. Preliminary evaluation was accomplished at night, since the dark condition was assumed to be the most critical situation for potential inadvertent runway intrusions. During this major portion of the evaluation effort, all of the critical characteristics were determined. Additional limited daytime testing was also conducted, using a system having the characteristics that had been determined as most effective at night, to validate the previously obtained data and to establish the required daytime intensity levels.

The tests compared flash rates of 30, 40, 50, 60, and 120 flashes per minute. Intensities were compared by varying the voltages applied to the traffic signal lamps. The three voltges used were 120, 85, and 60 volts with corresponding levels of 100, 30, and 10 percent of rated intensity. The fixtures were tested at four different distances from the edge of the taxiway and heights above grade. These were 10, 20, 35, and 38 feet from the pavement edge and 30, 36, 42 and 48 inches above grade, respectively. It is noted that heights above grade were selected based on the maximum allowable as outlined in AC 150/5340-18A "Taxiway Guidance Sign System." The angles at which the fixtures were toed-in toward the taxiway were 0, 10, 20, and 30 degrees. Vertical aiming angles, above the horizontal, were 0, 10, 20, and 30 degrees.

Pilots were given the briefing sheet (figure 3) prior to the evaluation test and allowed to ask questions. Aircraft were then taxied from near the intersection of runway 8-26 and taxiway A north to the intersection of runway 13-31. Once the pilot had been afforded the opportunity to observe the light configuration, the aircraft was stopped and the pilots completed a questionnaire (figure 4).

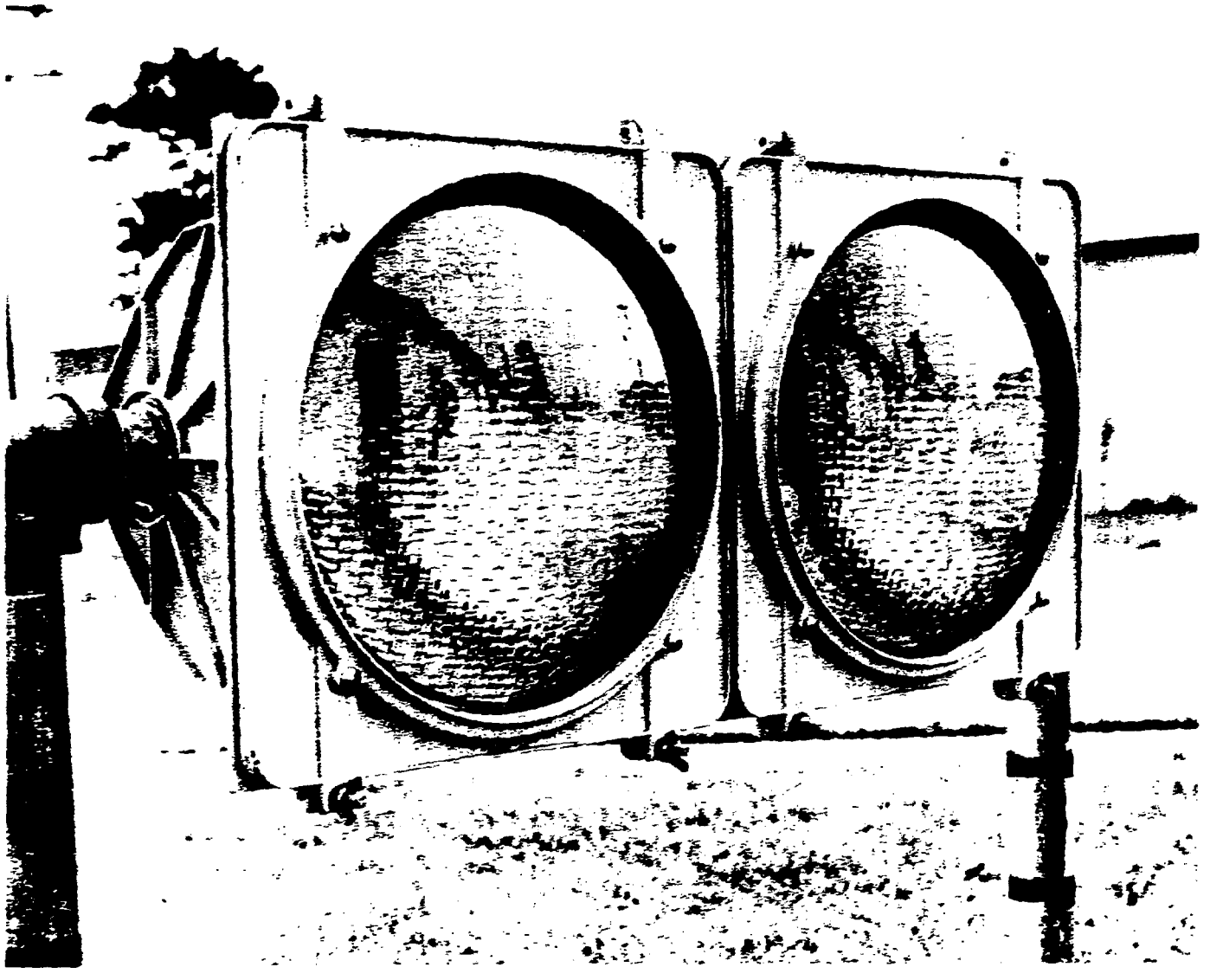
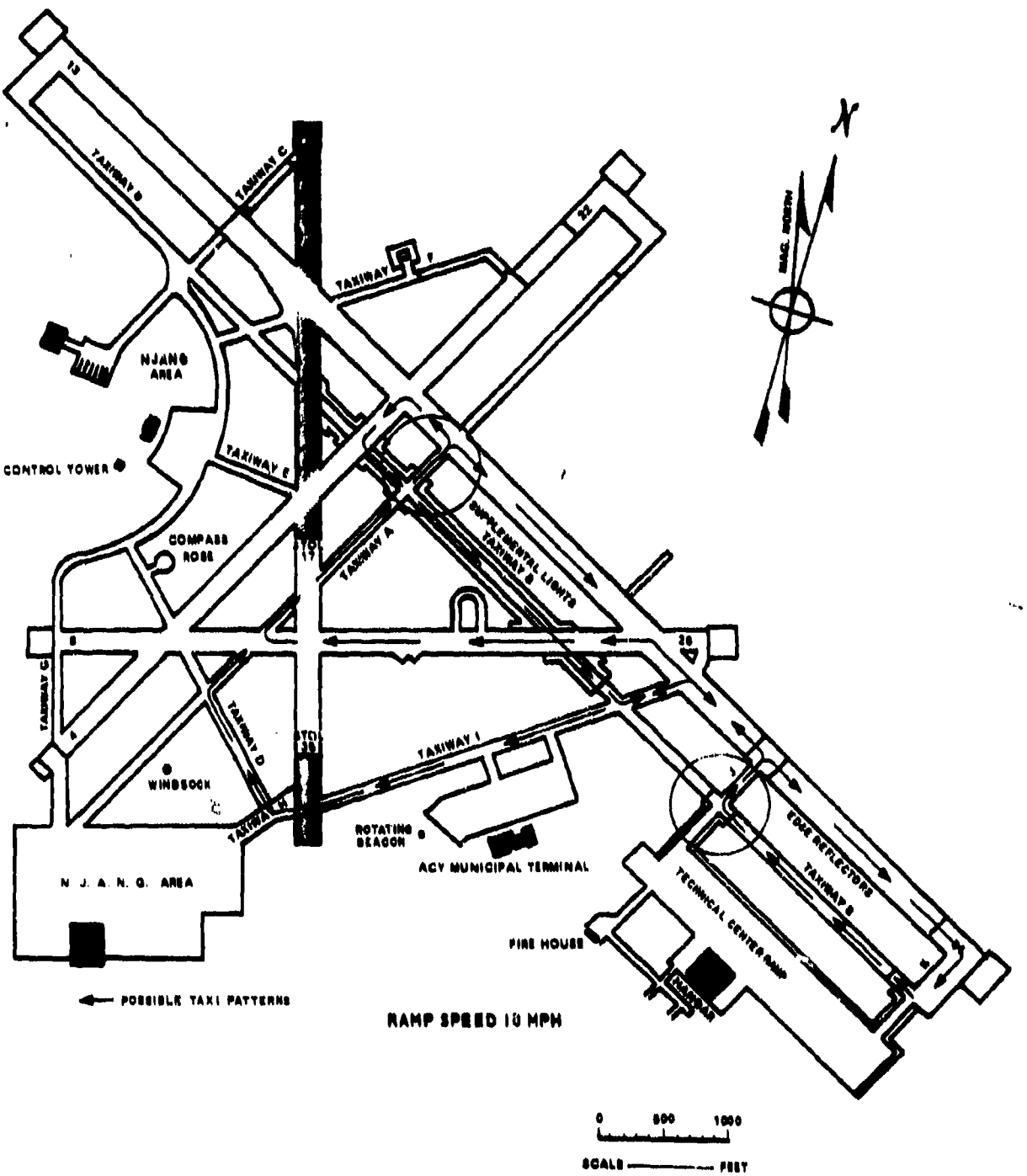


FIGURE 1. TAXI-HOLDING POSITION LIGHT



NAFEC/ATLANTIC CITY AIRPORT, ATLANTIC CITY, NEW JERSEY

FIGURE 2. TAXI-PATTERN FOR TEST

PILOT BRIEFING

EVALUATION OF SUPPLEMENTAL LIGHTS FOR CAUTION BARS (PROJECT 081-502-590)

You will be taxiing an aircraft toward the supplemental lights and caution bar located south of runway 13/31 on taxiway A. See attached diagram.

The supplemental lights will be two flashing lights on both sides of the taxiway. You will stop short (approximately 10 ft.) and then answer several questions (see attached questionnaire). While you are doing this the lights that are in front of the aircraft will be removed by test personnel. When you are told that it is clear you can continue to taxi for another test run.

This evaluation is being done to determine the desired characteristics of the supplemental lights. These lights may be used to suupplement the caution bar at locations that have problems with snow covered taxiways, high-cockpit aircraft (cockpit cut off angle) or inadvertant runway transgressions.

Thank you for your help.

Larry Hackler
x3316

FIGURE 3. PILOT BRIEFING

EVALUATION SUPPLEMENTAL LIGHTS FOR CAUTION BARS

Project 081-502-590

TYPE AND MODEL AIRCRAFT_____ DATE_____

VISIBILITY_____ TEST CONFIGURATION (SUPPLIED BY TEST PERSONNEL)_____

1. HOW WOULD YOU EVALUATE THE INTENSITY OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM

2. HOW WOULD YOU EVALUATE THE FLASH RATE OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
MUCH TOO FAST	TOO FAST	ABOUT RIGHT	TOO SLOW	MUCH TOO SLOW

3. HOW WOULD YOU EVALUATE THE DISTANCE OF THE SUPPLEMENTAL LIGHTS FROM THE EDGE OF THE TAXIWAY?

1	2	3	4	5
MUCH TOO CLOSE	TOO CLOSE	ABOUT RIGHT	TOO FAR AWAY	MUCH TOO FAR AWAY

4. WHICH SUPPLEMENTAL LIGHT DID YOU PREFER?

1	2	3
PREFER LEFT	NO PREFERENCE	PREFER RIGHT

5. HOW WOULD YOU EVALUATE THE USEFULNESS OF THE SUPPLEMENTAL LIGHTS IN LOCATING THE TAXIWAY/RUNWAY HOLD LINES OR CAUTION BARS?

1	2	3	4	5
VERY USEFUL	USEFUL	NO VALUE	DISTRACTING	VERY DISTRACTING

COMMENTS:

FIGURE 4. QUESTIONNAIRE USED TO COLLECT DATA

RESULTS

NIGHTTIME EVALUATION

The following seven variables were evaluated at night:

1. Intensity
2. Flash Rate
3. Distance from T/W Edge
4. Lens Diameter
5. Toe-In Angle
6. Vertical Angle (Pitch Up)
7. Overall Usefulness

The questionnaire results are shown in tables 1 through 6.

1. Intensity

The results on the intensity tests (table 1) show a preference for the 30 percent light intensity at night. The results indicate that maximum 100 percent intensity would also be acceptable. The maximum intensity for the equipment tested is 820 cd and 1600 cd for the 8-inch and 12-inch lights, respectively.

2. Flash Rate

The flash rate judged most acceptable was between 58 and 60 flashes/minute. The 58 flashes/minute has the advantage of using equipment that is already commercially available with this fixed flash rate (table 2).

3. Distance

Pilot opinion data, as to optimum distance and height for the system, were inconclusive, with no strong preference registered (table 3). The entire range of heights and distances displayed for evaluation seemed to evoke acceptable assessments by the pilots, with the intermediate values of 20-foot distance and 36-inch height being acceptable. This compromise location would appear to offer adequate obstacle clearance for all aircraft while maximizing effectiveness of the visual signal during low visibility weather conditions.

4. Lens Diameter

The diameter of the lenses and therefore the physical dimensions of the light did not influence the responses of the subject pilots at night (table 4).

5 & 6. Orientation (Toe-In and Vertical Angle)

As with the determination of optimum distance, pilot opinion data did not reveal a preference for any particular combination of toe-in and vertical angles (table 5). It seems probable that the photometric beamspread characteristics of the chosen fixture were sufficiently broad so that variations in orientation did not affect or detract from signal effectiveness. Since there was no preference for orientation, a toe-in of 20 degrees to direct the main beam of the light approximately 100 feet before the taxi-holding position is considered appropriate as it will

TABLE 1. INTENSITY TEST RESULTS

Intensity (Night) 10%

1. HOW WOULD YOU EVALUATE THE INTENSITY OF THE SUPPLEMENTAL LIGHTS?

1	2	5 3	3 4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM

Intensity (Night) 30%

1	1 2	16 3	1 4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM

Intensity (Night) 100%

1	2	4 3	4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM

Intensity (Day) 30%

1. HOW WOULD YOU EVALUATE THE INTENSITY OF THE SUPPLEMENTAL LIGHTS?

1	2	3	6 4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM

Intensity (Day) 100%

1	2	6 3	4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM

TABLE 2. FLASH RATE TEST RESULTS

Flash Rate (30 flash/min)

2. HOW WOULD YOU EVALUATE THE FLASH RATE OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
		2	2	
MUCH TOO FAST	TOO FAST	ABOUT RIGHT	TOO SLOW	MUCH TOO SLOW

Flash Rate (40 flash/min)

2. HOW WOULD YOU EVALUATE THE FLASH RATE OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
		2	2	
MUCH TOO FAST	TOO FAST	ABOUT RIGHT	TOO SLOW	MUCH TOO SLOW

Flash Rate (58 flash/min)

2. HOW WOULD YOU EVALUATE THE FLASH RATE OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
	1	17	1	
MUCH TOO FAST	TOO FAST	ABOUT RIGHT	TOO SLOW	MUCH TOO SLOW

Flash Rate (60 flash/min)

2. HOW WOULD YOU EVALUATE THE FLASH RATE OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
	1	3	1	
MUCH TOO FAST	TOO FAST	ABOUT RIGHT	TOO SLOW	MUCH TOO SLOW

Flash Rate (120 flash/min)

2. HOW WOULD YOU EVALUATE THE FLASH RATE OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
2	2			
MUCH TOO FAST	TOO FAST	ABOUT RIGHT	TOO SLOW	MUCH TOO SLOW

TABLE 3. DISTANCE TESTS RESULTS

Distance 10ft

3. HOW WOULD YOU EVALUATE THE DISTANCE OF THE SUPPLEMENTAL LIGHTS FROM THE EDGE OF THE TAXIWAY?

1	2	3	4	5
MUCH TOO CLOSE	TOO CLOSE	ABOUT RIGHT	TOO FAR AWAY	MUCH TOO FAR AWAY
		1	1	

Distance 20ft

3. HOW WOULD YOU EVALUATE THE DISTANCE OF THE SUPPLEMENTAL LIGHTS FROM THE EDGE OF THE TAXIWAY?

1	2	3	4	5
MUCH TOO CLOSE	TOO CLOSE	ABOUT RIGHT	TOO FAR AWAY	MUCH TOO FAR AWAY
		9	1	

Distance 35ft

3. HOW WOULD YOU EVALUATE THE DISTANCE OF THE SUPPLEMENTAL LIGHTS FROM THE EDGE OF THE TAXIWAY?

1	2	3	4	5
MUCH TOO CLOSE	TOO CLOSE	ABOUT RIGHT	TOO FAR AWAY	MUCH TOO FAR AWAY
		1		1

Distance 38ft

3. HOW WOULD YOU EVALUATE THE DISTANCE OF THE SUPPLEMENTAL LIGHTS FROM THE EDGE OF THE TAXIWAY?

1	2	3	4	5
MUCH TOO CLOSE	TOO CLOSE	ABOUT RIGHT	TOO FAR AWAY	MUCH TOO FAR AWAY
	1	14	2	

TABLE 4. LENS DIAMETER RESULTS

Lens Diameter Preference (Night 10%)

4. WHICH SUPPLEMENTAL LIGHT DID YOU PREFER?

2	1	5
1	2	3
8-INCH DIAMETER	NO PREFERENCE	12-INCH DIAMETER

Lens Diameter Preference (Night 30%)

9	5	9
1	2	3
8-INCH DIAMETER	NO PREFERENCE	12-INCH DIAMETER

Lens Diameter Preference (Night 100%)

1	1	2
1	2	3
8-INCH DIAMETER	NO PREFERENCE	12-INCH DIAMETER

Lens Diameter Preference (Day 30%)

0	1	5
1	2	3
8-INCH DIAMETER	NO PREFERENCE	12-INCH DIAMETER

Lens Diameter Preference (Day 100%)

0	1	5
1	2	3
8-INCH DIAMETER	NO PREFERENCE	12-INCH DIAMETER

TABLE 5. ORIENTATION RESULTS

Toe-In 10°

1. HOW WOULD YOU EVALUATE THE INTENSITY OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM
		1	1	

Toe-In 20°

1	2	3	4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM
		2	1	

Toe-In 30°

1	2	3	4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM
		2		

Vertical 10°

1. HOW WOULD YOU EVALUATE THE INTENSITY OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM
		1	1	

Vertical 20°

1. HOW WOULD YOU EVALUATE THE INTENSITY OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM
		2		

Vertical 30°

1. HOW WOULD YOU EVALUATE THE INTENSITY OF THE SUPPLEMENTAL LIGHTS?

1	2	3	4	5
MUCH TOO BRIGHT	TOO BRIGHT	ABOUT RIGHT	TOO DIM	MUCH TOO DIM
		2	1	

allow the taxi-holding position light to be seen at the caution bar and on the taxiway approaching the caution bar. A vertical angle of 10 degrees is a resonable compromise to accomodate both high and low cockpit heights.

7. Overall Usefulness

The subject pilot rating of the taxi-holding position lights was that the concept could be very useful (table 6). The only reservation expressed was that these lights should not be used at every runway entrance. They should be employed only where operational experience shows they are NEEDED. The lights should be displayed (lighted) only when the runway is active to insure that whenever a pilot sees them, the pilot will be immediately aware of their significance. Also since this light is not extinguished to allow a pilot to continue, the possibility of a pilot interpreting a failure of the light as a "go" signal is reduced.

TABLE 6. OVERALL USEFULNESS RESULTS

Usefulness (Day)

5. HOW WOULD YOU EVALUATE THE USEFULNESS OF THE SUPPLEMENTAL LIGHTS IN LOCATING THE TAXIWAY/RUNWAY HOLD LINES OR CAUTION BARS?

12	19	3	1	
1	2	3	4	5
VERY USEFUL	USEFUL	NO VALUE	DISTRACTING	VERY DISTRACTING

Usefulness (Night)

5. HOW WOULD YOU EVALUATE THE USEFULNESS OF THE SUPPLEMENTAL LIGHTS IN LOCATING THE TAXIWAY/RUNWAY HOLD LINES OR CAUTION BARS?

5	7			
1	2	3	4	5
VERY USEFUL	USEFUL	NO VALUE	DISTRACTING	VERY DISTRACTING

DAYTIME EVALUATION

The following three variables were tested during the day:

1. Intensity
2. Lens Diameter
3. Overall Usefulness

The questionnaire results are shown in tables 1, 4, and 5. The other variables were set as follows based on the results under nightime conditions:

Flash Rate: 58 flashes/minute
Distance from T/W Edge: 20 feet and 36 inches above grade
Toe-In Angle: 20 degrees
Vertical Angle (Pitch-Up): 10 degrees

1. Intensity

The intensity testing resulted in a pilot preference for the 100 percent level (table 1). If it were desired to have a variable intensity for night and day, then 30 percent intensity should be used for night and 100 percent for day.

2. Lens Diameter

Pilots indicated a preference for the 12-inch diameter lens (see table 4).

3. Overall Usefulness

The pilots rated the taxi-holding position lights as useful or very useful (see table 5.)

PHOTOMETRIC TESTS (HORIZONTAL AND VERTICAL COVERAGE).

The photometric data for the two taxi-holding position lights used are shown in figures 5, 6, 7, and 8. The horizonatal and vertical coverage provided by the test lights and shown by the photometric data would be adequate.

CONCLUSIONS AND RECOMMENDATIONS

The following equipment characteristics were determined to be the most effective:

1. Intensity: 30 percent for night and 100 percent for day
2. Flash Rate: 58 flashes/minute
3. Distance from T/W Edge: 20 feet from pavement edge and 36 inches above grade.
4. Lens Diameter: 12 inches
5. Toe-in angle: 20 degrees
6. Vertical Angle (pitchup): 10 degrees
7. Horizontal and vertical coverage of light beam: as shown by photometric data.

The use of supplemental lights with the above characteristics will provide enhanced identification of the taxi-holding position. To further validate the results of this limited evaluation, it is recommended that additional in-service testing of the system should be accomplished at an air-carrier airport.

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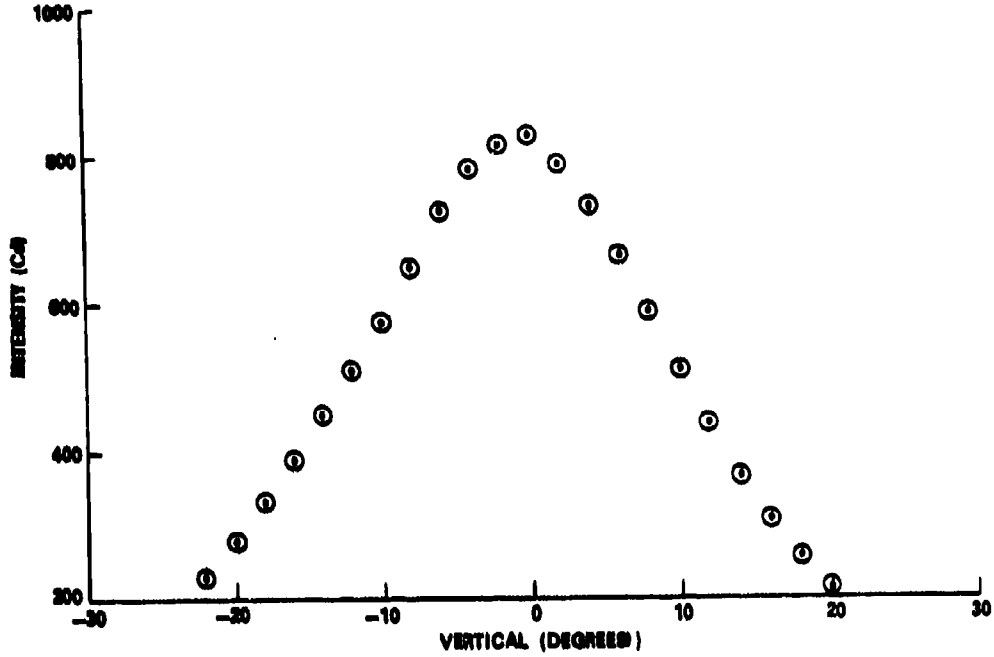

FIGURE 5. PHOTOMETRIC DATA FOR TAXI-HOLDING POSITION LIGHT WITH 8-INCH DIAMETER LENS (VERTICAL)

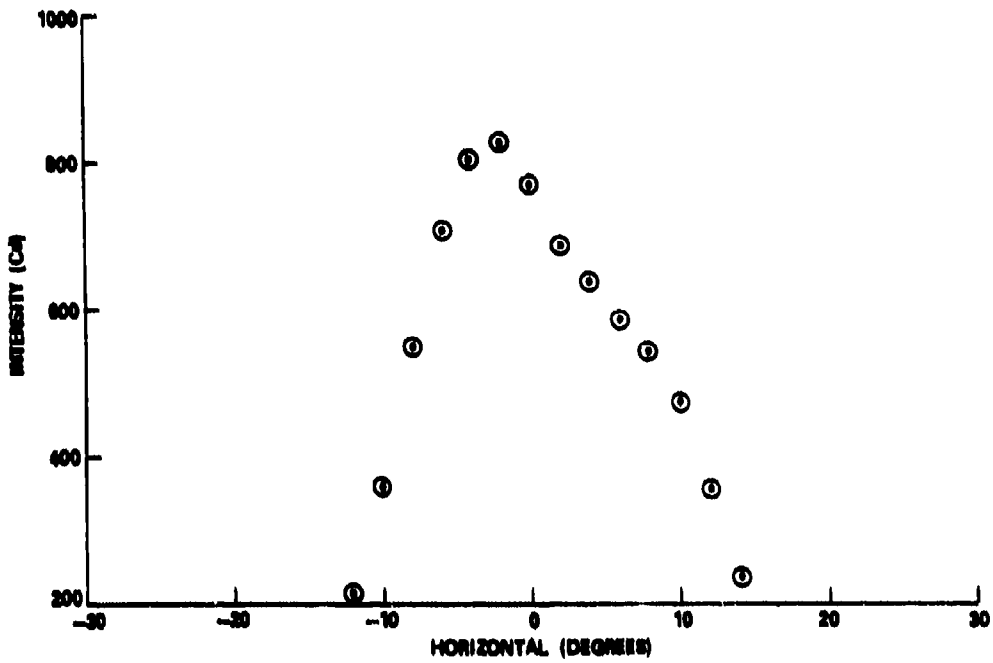

FIGURE 6. PHOTOMETRIC DATA FOR TAXI-HOLDING POSITION LIGHT WITH 8-INCH DIAMETER LENS (HORIZONTAL)

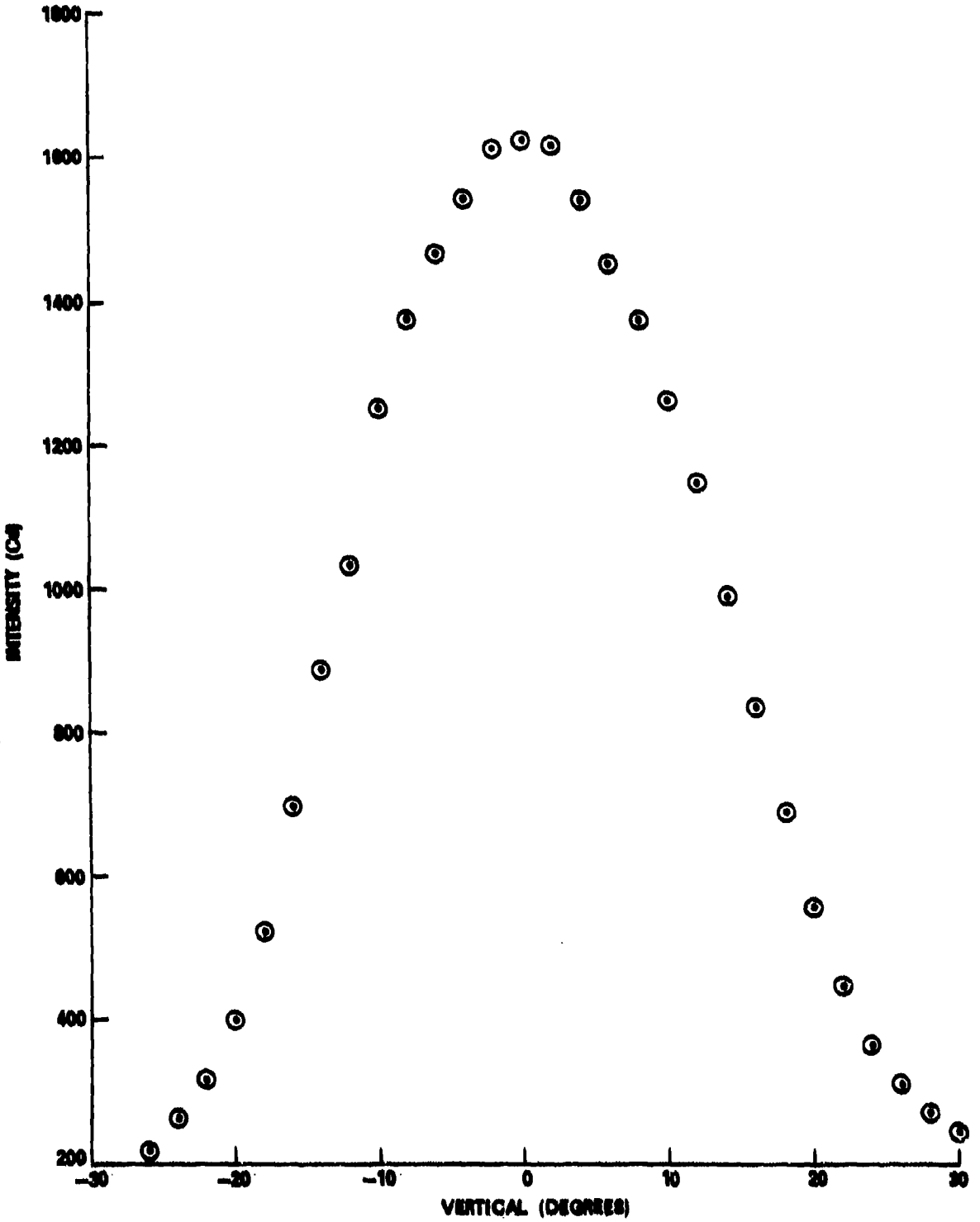

FIGURE 7. PHOTOMETRIC DATA (VERTICAL) FOR TAXI-HOLDING POSITION LIGHT WITH 12-INCH DIAMETER LENSE

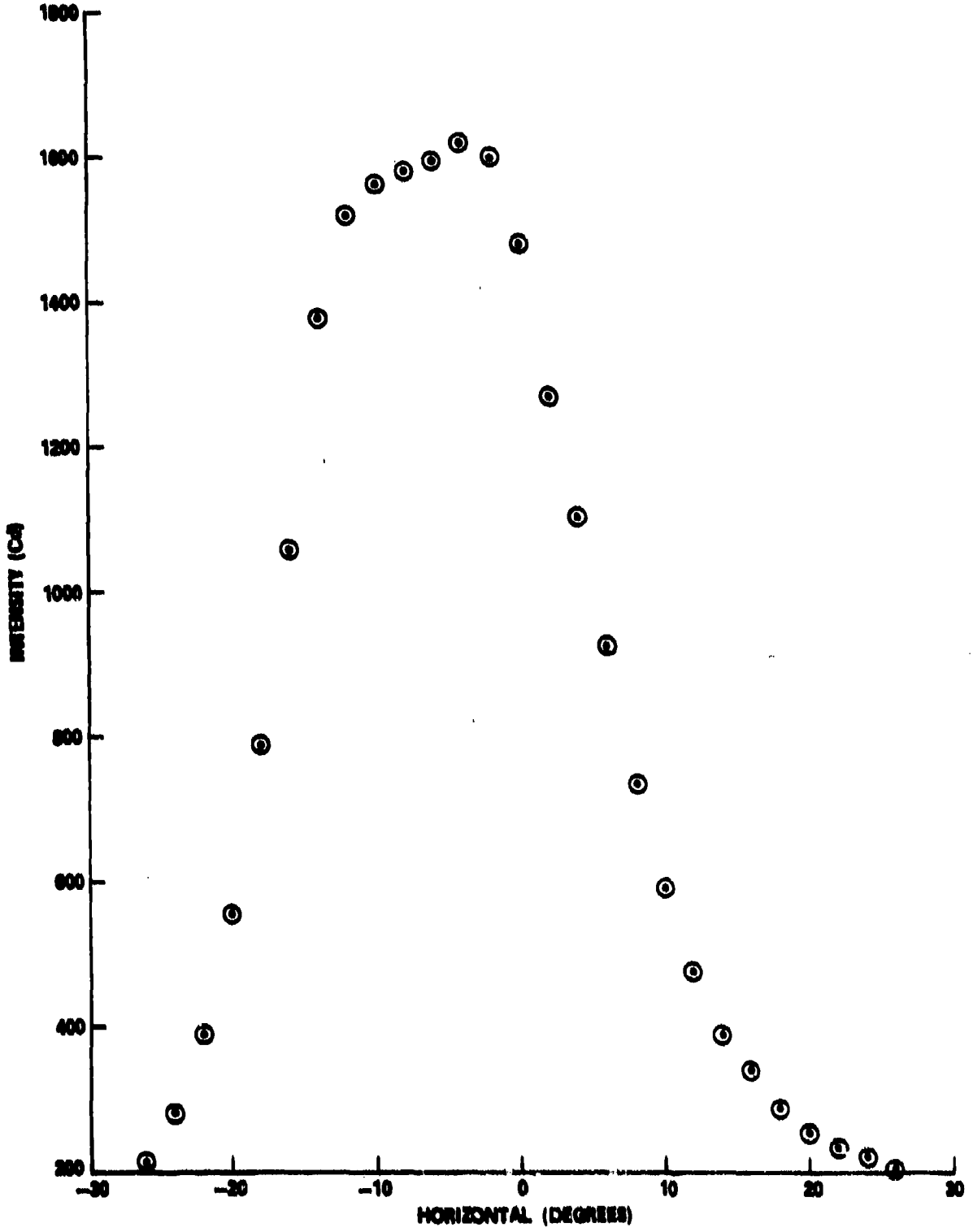

FIGURE 8. PHOTOMETRIC DATA (HORIZONTAL) FOR TAXI-HOLDING POSITION LIGHT WITH 12-INCH DIAMETER LENSE

3. Report of the Ninth Meeting of the Visual Aids Panel (VAP) 1980, Montreal, 3-21 November 1980 (ICAO Document VAP 9/WP-6).

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